

Applic. No.: 10/715,019
Amdt. Dated August 26, 2004
Reply to Office action of June 15, 2004

REMARKS/ARGUMENTS

Reconsideration of the application is requested.

Claims 1-13 remain in the application. Claim 1 has been amended.

In the paragraph bridging pages 2 and 3 of the above-mentioned Office action, claims 1, 3-5, 9, and 11-13 have been rejected as being unpatentable over Hieda et al. (US Pat. No. 5,998,821) in view of Liu et al. (US Pat. No. 6,548,671 B1) and further in view of Komura et al. (US Pat. No. 5,423,941) under 35 U.S.C. § 103(a).

In the second paragraph on page 6 of the above-mentioned Office action, claim 2 has been rejected as being unpatentable over Hieda et al. in view of Liu et al. and in view of Komura et al. and further in view of Sasaki et al. (US Pat. No. 6,669,855 B2) under 35 U.S.C. § 103(a).

In the first paragraph on page 7 of the above-mentioned Office action, claim 6 has been rejected as being unpatentable over Hieda et al. in view of Liu et al. and in view of Komura et al. and further in view of Peinador et al. (US Pat. No. 6,358,359 B1) under 35 U.S.C. § 103(a).

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In the last paragraph on page 7 of the above-mentioned Office action, claims 7-8 have been rejected as being unpatentable over Hieda et al. in view of Liu et al. and in view of Komura et al. and further in view of Howald (US Pat. No. 6,400,458 B1) under 35 U.S.C. § 103(a).

In the second paragraph on page 8 of the above-mentioned Office action, claim 10 has been rejected as being unpatentable over Hieda et al. in view of Liu et al. and in view of Komura et al. and further in view of Koburger, III (US Pat. No. 6,503,813 B1) under 35 U.S.C. § 103(a).

The rejections have been noted and claim 1 has been amended in an effort to even more clearly define the invention of the instant application. Support for the changes is found in Fig. 3 and the corresponding description of the specification.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 1 calls for, inter alia:

in a second etching step, dry etching the semiconductor substrate, the collar isolation and inner electrodes of the trench capacitor with an etching gas including silicon fluoride and oxygen.

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Hieda et al. do not consider switching the etch chemistry during the etching of a shallow isolation trench for a trench capacitor having an isolation collar. This fact has already been acknowledged by the Examiner.

Liu et al. change the etch chemistry when the isolation collar is reached in order to cope with the different selectivities between silicon and the isolation material of the collar (Figs. 3C and 3D). The second etch step in Liu et al. uses CF₄-based etch chemistry. In contrast, the second etch step according to the invention of the instant application is based on CF₄ and O₂ chemistry, which is not disclosed in Liu et al.

Komura et al. use CF₄ and O₂ in example 1 and comparative example 3 as shown in Table 1. However, since Komura et al. have a totally different object than the invention of the instant application, a person skilled in the art would not be taught by Komura et al. to use CF₄ and O₂ to etch the inner electrode, the isolation collar as well as the substrate simultaneously. Komura et al. desire to etch a trench into bulk silicon as shown, for example, in Fig. 1. After opening the mask, the process in Komura et al. will only see a homogenous material, e.g. silicon, into which the trench is to be etched. In contrast, in the invention of the instant application, at the end of the first etch step the exposed

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bottom surface of the trench to be etched exhibits a configuration of different materials, i.e. the semiconductor substrate, the inner electrode of the capacitor as well as the isolation layer. There are at least two substantially different materials, i.e. isolation material and silicon (polycrystalline and crystalline). Komura et al. do not provide a hint to use CF_4/O_2 in order to continue from where the first etch step of the invention of the instant application ends.

The above observation is supported by the different results achieved through Komura et al. and through the invention of the instant application. The invention of the instant application achieves an even and flat bottom surface of the trench to be etched (see page 3, line 18). Komura et al. prefer to obtain a round bottom (see column 1, line 19). The invention of the instant application is useful to etch a shallow trench, which may be used to isolate two trench capacitors from each other. Komura et al. is directed to the etching of a deep trench to incorporate a trench capacitor.

The gas composition CF_4 and O_2 is certainly known for etching features in semiconductor technology. Komura et al. use CF_4/O_2 in a mixture including HBr and other chemicals for etching a deep trench. The gas composition is used to etch the trench

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from the very beginning to the very end. Komura et al. do not relate to the situation of the invention of the instant application where a trench has already been established during a first etch step and where the semiconductor substrate, the isolation collar and the inner electrode of a capacitor are exposed within the bottom of the trench. Hence, Komura et al. disclose a one-step process to etch a deep trench into bulk material, and the invention of the instant application concerns a two-step process of etching a shallow trench for a trench capacitor having an isolation collar. Komura et al. disclose using CF₄/O₂ for a different environment and purpose than in the invention of the instant application. Thus, Komura et al. cannot teach switching to CF₄/O₂ chemistry at the point where the isolation collar is reached in a two step etch process in order to complete the etching of the substances and obtain a flat bottom surface of the trench.

It is accordingly believed to be clear that none of the references, whether taken alone or in any combination, either show or suggest the features of claim 1. Claim 1 is, therefore, believed to be patentable over the art and since all of the dependent claims are ultimately dependent on claim 1, they are believed to be patentable as well.

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In view of the foregoing, reconsideration and allowance of claims 1-13 are solicited.

In the event the Examiner should still find any of the claims to be unpatentable, counsel would appreciate a telephone call so that, if possible, patentable language can be worked out.

If an extension of time for this paper is required, petition for extension is herewith made. Please charge any fees which might be due with respect to 37 CFR Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,

For Applicants

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